Application Brief

Demystifying Isolation Certification Standards: Optocouplers vs Opto-emulators

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Overview

Traditional optocouplers provide isolation using an LED and a photodiode. LED-based optocouplers are certified according to IEC 60747-5-5, which is the international optocoupler standard that has been active since 2007. Updates to the current (2.0) edition were released in 2020.

TI's new opto-emulators use silicon dioxide (SiO_2) isolation technology to provide isolation. As a result, opto-emulators and digital isolators are certified according to a different standard (IEC 60747-17) that became the international digital isolator standard in September 2020.

The new digital isolator standard (IEC 60747-17) has many test requirements that are more stringent and detailed than the optocoupler standard (IEC 60747-5-5). Opto-emulators and digital isolators are evaluated to a criterion that provides a comprehensive understanding of device performance and capability.

IEC 60747-17 versus IEC 60747-5-5 at a glance

Figure 1 provides an overview comparing the digital isolator standard (IEC 60747-17) and the optocoupler standard (IEC 60747-5-5).For additional information on IEC 607 47-17 specifications, see [FAQ] High-Voltage Isolation Parameters.

Criteria / Parameter	IEC 60747-17 (Digital Isolator Standard)	IEC 60747-5-5 (Optocoupler Standard)
Max surge isolation voltage (in oil) (V_{IOSM}) Max impulse voltage (in air) (V_{IMP})	• Reinforced surge test voltage = 1.3 x V_{IMP} • Basic surge test voltage = 1.3 x V_{IMP} • Reinforced surge minimum = 10 kV • 50 surge strikes (bipolar, 25 each polarity)	• V_{IMP} not defined in the standard • Reinforced surge test voltage = 10 kV • Basic surge test voltage = Not specified • Reinforced surge minimum = 10 kV • 50 surge strikes (bipolar, 25 each polarity)
Partial discharge initial test voltage ($V_{INI(b)}$) – Method b (Production test)	$V_{INI(b)}$ = 1.2 x V_{IOTM}	$V_{INI(b)}$ not defined in the standard
Partial discharge measuring test voltage ($V_{PD(M)}$)	Reinforced = 1.875 x V_{IORM} Basic = 1.5 x V_{IORM}	Reinforced = 1.875 x V_{IORM} Basic = 1.5 x V_{IORM}
Time Dependent Dielectric Breakdown (TDDB) Test to determine Working voltage (V_{IOWM})	Test defined in the standard and supplier needs to provide data to VDE for approval	TDDB not defined in the standard.
Minimum rated lifetime	Reinforced = 20 years x 1.5 (safety margin) Basic = 20 years x 1.2 (safety margin)	Minimum rated lifetime not defined in the standard.
Failure rate over lifetime	Reinforced = < 1 ppm Basic = < 1,000 ppm	Failure rate over lifetime not defined in the standard.

Figure 1. Isolation Standard Comparison - IEC 60747-17 versus IEC 60747-5-5

Details

Maximum impulse voltage (V_{IMP})

To differentiate between isolation performance in oil vs in air, IEC 60747-17 specifies that the isolation performance of a digital isolator is tested in both oil (V_{IOSM}) and in air (V_{IMP}). Whereas the optocoupler standard, IEC 60747-5-5, does not specify both parameters.

When the device is tested in oil, the possibility of arcing across the package is negated. Isolation performance in an application is not accurately represented without also testing in air (V_{IMP}). The digital isolator specification defines V_{IMP} for an in air isolation test and V_{IOSM} for isolation test in oil. Whereas the optocoupler specification only specifies V_{IOSM} and does not specify if the device is tested in air or oil.

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IEC 60747-17 defines V_{IMP} as a benefit to the customer to understand in system performance of a digital isolator. See the *Insulation Specifications* section of the data sheet for V_{IMP} and other IEC 60747-17 related specifications, and see [FAQ] What is Maximum Impulse Voltage (VIMP) for more information related to V_{IMP}.

The following sections show the key differences between the two standards:

Partial discharge test (production test): Method B testing

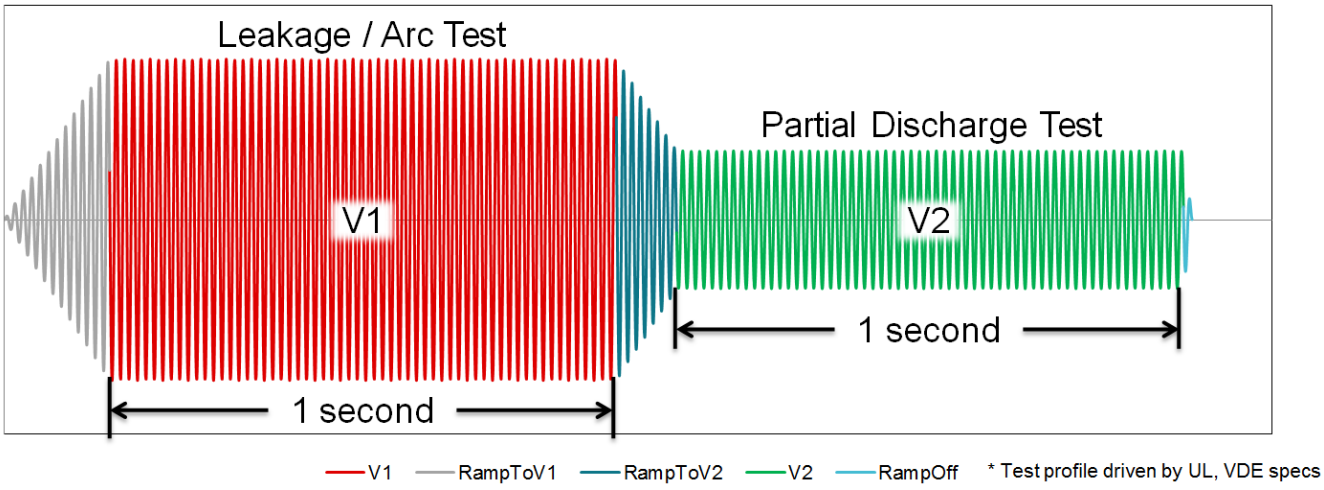

Figure 2. Method B Test Waveform

Partial Discharge of Digital Isolators and Opto-emulators are testing using the Method b testing. An example of a Method b1 test waveform is shown in Figure 2 which is defined by the IEC 60747-17 standard. Where V1 is the voltage that leakage testing is performed at and V2 is the voltage that partial discharge testing is performed at.

Isolation parameters are tested in production following the method B testing. Digital isolation devices are tested in production using the following procedure.

- One second at 1.2 × V_{IOTM} followed by one second at 1.875 × V_{IORM}.
  - Optocouplers only specify testing at one second at 1.875 × V_{IORM}.
- For example, for an isolator rated for 3.75 kV_{RMS} isolation is test at:
  - Reinforced isolators are tested at 6.36 kV_{PK} AC 50 Hz and 60 Hz followed by 1.33 kV_{PK} AC 50 or 60 Hz.
- Optocouplers are only required to test at 1.875 × V_{IORM} with no initial stress level voltage (V_{ini}) of one second at 1.2 × V_{IOTM}.

The digital isolator standard contains more stringent test conditions.

Time dependent dielectric breakdown (TDDB) testing

TDDB testing identifies life expectancy associated with the dielectric material of an isolator. TDDB is accelerated by applying an electric field across the dielectric at an increased temperature.

- TI runs TDDB testing across hundreds of units.
- The optocoupler standard does not require TDDB lifetime testing.

For more details on TDDB testing methodology, see *Enabling high voltage signal isolation quality and reliability*.

Conclusion

Due to rigorous testing through IEC 60747-17, TI has a high confidence in the longevity, robustness, and reliability of the isolation barrier. The additional specifications of IEC 60747-17 also can provide a picture of device performance and insulation capability over IEC 60747-5-5, which is the traditional optocoupler standard.

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